DLA-94-P30210

FORECASTING DLA SUPPLY MANAGEMENT BUSINESS BASE

SEPTEMBER 1994

FOR

DEPARTMENT OF DEFENSE
DEFENSE LOGISTICS AGENCY
Executive Director (Supply Management)
CAMERON STATION
ALEXANDRIA, VA 22304-6100

INSIGHT THROUGH ANALYSIS

DORO

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IN REPLY
REFER TO

FOREWARD

The Defense Logistics Agency (DLA) Directorate of Material Management - Supply (MMS) requested that DLA's Operations Research Office (DORO) investigate methods for forecasting its business base indicators that are sensitive to the changing fiscal and structural environment currently facing the Department of Defense (DoD). The DLA business base was forecasted from indicators of Military Service activity, personnel strength, and budget. This report documents and summarizes the efforts and conclusions reached in this study.

Thanks is given to the DLA Management Informations Systems Office (FOM) and the the Financial Systems and Control Office (FOX) for providing significant and substantial assistance in data and information retrieval for this project.

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EXECUTIVE SUMMARY

The requirements of the Defense Logistics Agency's customers are changing. Decreases in the Department of Defense budgets, base closures and realignments, lower Military end strengths, streamlining initiatives, and many other factors are combining to drastically change DLA's Material Management business base. A forecasting model is required to help managers identify the magnitude of the changes in advance so that they can take proactive steps to match resources with customer requirements. The historical trends upon which business has been based have primarily represented periods of budget growth. Therefore, the use of historical trends based on the old fiscal environment may be inappropriate in forecasting business in the new environment. DLA's Material Management Directorate is examining alternative techniques for forecasting gross demands, supply support requests, and gross sales. The DLA Operations Research Office (DORO) was tasked with investigating new approaches for forecasting business base indicators which did not assume the continuation of historical trends.

This study explored forecasting DLA business base using indicators of Service activity, budget items, and personnel strengths. The three objectives were to (1) research and evaluate forecasting methodologies previously developed and/or in use within the Department of Defense, other federal agencies, and the private sector, (2) identify key internal and external indicators effecting DLA hardware center business, and (3) develop a model to forecast gross sales, gross demands, and supply support requests for a period of at least five years for the four hardware centers. The premise of this analysis is that business base is related to these areas. A decrease or increase in the above would result in a change in business in roughly the same direction. Regression analysis and modeling were examined to forecast DLA business base indicators.

Regression was determined to provide the best forecast. The results indicate that DLA's Hardware Center's business base will decline and become relatively flat over the next six years. Each of the elements forecasted -- gross demands, supply support requests, and gross sales -- mirror this down turn. Sales will drop to approximately $3 billion per year given current conditions and the trends of decreasing manpower, operations activity, and funding. Gross

Demands will drop accordingly, and stabilize at approximately 11.5 million per year. Supply Support Requests will also deteriorate to a level of roughly 75,000 per year as fewer National Stock Numbers enter the inventory.

It is recommended that the forecasting methodology presented here be continued and updated as more information is available and trends develop. The business base indicators forecasted in this study for the next 6 years should be used in the overall strategic planning and evaluation process ongoing within DLA. The forecast should be expanded to include the Defense Fuel Supply Center (DFSC) and the Defense Personnel Support Center (DPSC).

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SECTION 1
INTRODUCTION

> "Future trends, including technological, economic, and other changes, must be predicted so that steps can be taken to deal with their effects. Facing up to the future and the uncertainty that surrounds it in an intelligent and pragmatic way is a critical necessity for today's manager. It requires accurate forecasting, effective planning, appropriate strategies, a great deal of creative thinking, an effective organization, and considerable implementation skills. The challenges involved are enormous." (Makridakis, pp. ix - x)

1.1 BACKGROUND

The Defense Logistics Agency (DLA) Material Management Supply Directorate (MMS) has requested development of a model to improve forecasts of its basic business. This is urgently needed to assist in both resource allocation and preparation of the Program Objective Memorandum (POM). Rapid changes in Department of Defense (DoD) budgets have increased the importance of good forecasts, while simultaneously hurting the usefulness of current forecasts. As stated above, steps need to be taken to deal with future trends -- the more proactive, the better.

In general, forecasting is heavily weighted toward projection of the past into the future, with some modification. In stable and consistent fiscal climates the future *will* tend to imitate the past. This is not currently what faces DoD. Consequently, the previous relationships between business base indicators and factors other than time may be the best reasonable means of predicting future business, and were therefore pursued. The current environment warrants a look at major DoD indicators in terms of budgets, the pace of operations, personnel, and their relationship to DLA's business. Why? The current DoD downsizing is unique. The last comparable downsizing occurred over forty years ago. That involved a DoD with very different weapons systems, organization, and administrative procedures facing a different threat. Its relevance to the present is limited. Concurrent with the present downsizing, global commitments of the United States Armed Forces appear to be increasing. At the same time that we are constricting, belt-tightening, and getting smaller, commitments and obligations of the United

States Armed Forces in areas throughout the globe exceed those of any time since the end of World War II. Additionally, the Joint Chiefs of Staff have stated that U.S. forces will maintain the ability to simultaneously fight and win two major regional conflicts.

We are planning to meet the conditions of the future, even with incomplete information and under ever-changing conditions. This report presents new research on development of a forecasting model more pertinent to the present environment. It relates DLA's business indicators to factors which can be predicted with reasonable accuracy. This involved determining what DoD variables and data elements have the greatest impact upon DLA workload.

1.2 SCOPE

This study encompasses the following four DLA hardware centers: the Defense Construction Supply Center (DCSC) in Columbus, Ohio; the Defense Electronics Supply Center (DESC) in Dayton, Ohio; the Defense General Supply Center (DGSC) in Richmond, Virginia; and the Defense Industrial Supply Center (DISC) in Philadelphia, Pennsylvania. The model will make an aggregate forecast for three business base areas: supply support requests, gross demands, and gross sales. The DLA data elements in this study are limited to the four supply centers listed previously. Additional data considered came from areas within the Department of Defense specifying military personnel strengths (active, reserve, and National Guard), operations tempo indicators (flying hours, steaming hours, etc.), and National Defense Budget figures. These data elements are discussed in detail in Section 2, and are presented in Appendix B. Data elements for all inputs will, at a minimum, be for the ten year period 1984-1993. Several inputs have data availability exceeding the minimum by anywhere from two to twenty years.

1.3 OBJECTIVES

The study has three objectives:

(1) Research and evaluate forecasting methodologies previously developed and/or in use within the Department of Defense, other federal agencies, and the private sector.

(2) Identify key internal and external indicators effecting DLA hardware center business.

(3) Develop a model to forecast gross sales, gross demands, and supply support requests for a period of at least five years for the four hardware centers.

SECTION 2
METHODOLOGY

2.1 OVERVIEW

This study examined the feasibility of forecasting the three business base areas of gross demands, supply support requests, and gross sales using proxies indicative of Department of Defense (DoD) activity. This approach is based on the assumption that increases and decreases in Military Service activity directly effect workload placed on DLA. This relationship is instinctively direct and logical, as the services are the Agency's primary customers, accounting for the largest proportion of total sales. As a starting point, a literature search was conducted to look for similar forecasting studies. A survey of several private sector corporations was also conducted to ascertain their methods and practices. Then different types of forecasting methods were investigated and evaluated for suitability. Collection and analysis of the information and data that has the best relationship to the business areas was ongoing throughout the project. Finally, the most appropriate evaluation measures were decided upon.

2.2 RESEARCH OF FORECAST METHODS

The first step in this project was research consisting of a literature search on the subject of forecasting. In this area we consulted government, academic, and private industry sources. Government sources include the Defense Logistics Studies Information Exchange (DLSIE) located at Fort Lee, Virginia, the Defense Technical Information Center (DTIC) and the DLA library at Cameron Station, Virginia. Additionally, previous DORO studies referenced in the annually published "Compendium of Operations Research and Economic Analysis Studies" were consulted. Academic sources included Virginia Commonwealth University and the Colorado School of Mines. There are extensive academic writings in the area of forecasting. Academic publications include the "Journal of Forecasting" and the "International Journal of Forecasting." Other sources of forecasting discussion were "Interfaces" and the "Production and Inventory Management Journal". Numerous undergraduate and graduate level texts are also available on

the subject as forecasting is taught in most business and engineering schools. Private sector companies surveyed include Wal-Mart Corporation of Bentonville, Arkansas; Sears, Roebuck and Company Headquarters in Chicago, Illinois; and Timecorp, Inc. of Atlanta, Georgia. After completing the literature search and selecting the appropriate forecasting method, the key internal and external indicators need to be identified.

2.3 IDENTIFY KEY INTERNAL AND EXTERNAL INDICATORS

The potential influences considered were areas and activity within the Department of Defense expected to effect the business activity of DLA. These areas include:

(a) Operations activity/tempo indicators. These data elements came from the military services and are measures of training activity. The sources for this data are listed in Appendix D. They include

- Army flying hours
- Air Force flying hours
- Navy flying hours
- Navy steaming hours
- Army Tank training miles.

(b) Department of Defense Outlays. Outlays, or expenditures, are the liquidation of the Government's obligations, and generally represent cash payments. This information is available in the "National Defense Budget Estimates" published by DoD. The three titles considered were:

- Operations and Maintenance (O&M)
- Procurement
- Research, Development, Test, and Evaluation (RDT&E)

(c) Department of Defense Budget Authority (BA). BA is the authority to incur legally binding obligations of the Government which will result in immediate or future expenditures. Most Defense BA is provided by Congress in the form of enacted appropriations. This information is also available in the "National Defense Budget Estimates" published by DoD. The three titles considered were:

- Operations and maintenance
- Procurement
- RDT&E

(d) Military personnel end strengths. This was the total number of military personnel in the armed forces at the end of the fiscal year. These figures reflect the individual services POM submissions to the Comptroller for the Office of the Secretary of Defense (OSD) for inclusion in the President's Budget submission. The categories considered here were:

- Number of active duty personnel
- Number of Reserve and National Guard personnel

All data used in this study is unclassified. Actual data used is found in Appendix B, and a list of sources is in Appendix D.

2.4 VALIDATE FORECASTS

Once the forecast methodology is determined through the literature search and identification of the key indicators, it is then necessary to test the validity of the outputs from that forecast methodology. There are several methods for approaching this. The methods used for this study were three. Backcasting is used to forecast historical data. These values are are then evaluated using the Mean Absolute Percentage Error Mean and the R-squared (R^2). The Mean Absolute Percentage Error is the average amount that a backcast was above or below the actual value for that time period, and R^2 is the value between zero and one that attests to how much of the

variation in the predicted element is explained within the equation itself. These are explained below.

2.4.1 MEAN ABSOLUTE PERCENTAGE ERROR

Various methods have been devised to measure the errors generated by forecasting procedures. These basically involve generating forecasts for past periods where the actual values of the forecasted variable are known. This is called *backcasting*. These forecasts are then compared with the actual value of the variable to calculate the forecast error for each period. The formula for the error in each period is:

$$e_T = F_T - X_T$$

where: e_T = forecast error in period T

F_T = forecast value in period T

X_T = actual value in period T

This error figure, e, gives the amount above or below the actual value in the period being evaluated. It is normally more useful to compute the forecasting errors in terms of percentages rather than amounts. The *mean absolute percentage error* (MAPE) is computed by finding the absolute error in each period, dividing this by the actual value of that period, then averaging these absolute percentage errors. The formula for this calculation is

$$\text{MAPE} = \frac{\sum \frac{|F_T - X_T|}{X_T}}{n}$$

where n = number of periods being evaluated.

This was one measure used in evaluating the forecasts made in this study. The forecasts having the lowest MAPE were evaluated in conjuction with their R^2 for suitability and accuracy.

2.4.2 R-SQUARED (R^2)

The R-squared (R^2) is called the coefficient of determination. The R^2 is the amount of error explained by the equation. It is used to compare the results of different "what-if" scenarios using different combinations of the influencing elements. This figure is between zero and one. The closer the number is to one, the more appropriate the combination of elements being used for forecasting.

SECTION 3
FINDINGS

3.1 LITERATURE SEARCH

The results of the literature search and survey of private industry were mixed. Private companies contacted were very protective of their forecasting methods and techniques. Each of the people interviewed felt internal company forecasts and strategic planning are proprietary information to be closely guarded, and definitely not for public dissemination or discussion. The academic journals investigated were short on specifics and long on generalities.

Nonetheless, several key insights were arrived at during this phase. Regression methods would work best in forecasting DLA business activities. For the past twenty years, few United States companies have made much effort to plan beyond the three to five year time span. In this regard, DLA is following the private sector by looking at the same time frame for planning. Also, a common thread in the research was that objective methods are preferable to subjective methods and regression models are better than time series models when relationships are known and data is available. This provided reinforcement for this project and its methodology.

3.2 FORECASTING METHODS

Forecasting methods are generally classified as either subjective or objective. A subjective method is based on human judgment. This method may take on many forms and includes, but is not limited to, executive opinion, customer surveys, and sales force composites. These are for the most part opinions, and are part of any discussion of business. The purpose of this study was to find a easily understood forecast based on sound quantitative methodology. Objective forecasting methods are those in which the forecast is derived from an analysis of data. Of the objective methods, the two most used are regression analysis and time series. In the search for the best method to use on this project, the object methods were evaluated.

3.2.1 TIME SERIES

Time series methods require no information other than the past values of the variable(s) being considered. This is a collection of past observations drawn at single points in time, usually evenly spaced (i.e. yearly, quarterly, etc.). The idea is that information can be inferred from the pattern of past observations and can be used to forecast future values of the series. In time series we attempt to isolate the patterns that arise most often. It is this fact of being backward looking in nature that made this method unsuitable for this study. The nature of DoD dynamics at this point in time does not allow DLA to be considering past trends in order to forecast future business. The relationships of increasingly changing activity indicators and budgets necessitates the use of regression analysis for forecast modeling.

3.2.2 REGRESSION ANALYSIS

Regression analysis is the most common and useful method chosen for forecasting. Regression analysis is a useful statistical technique for exploring and modeling relationships between variables. There are several fundamental steps in the application of regression analysis to the problem of forecasting. First is the identification of likely predictors that are thought to cause changes in the business base. Then, identification of the relationships between the variables. Subsequently, we construct models for those relationships appearing to be the most reasonable for forecasting purposes. The successful formulation of the model does not imply a influential relationship between variables. Instead, influence must be established outside the bounds of the sample data used to construct the regression model. Reason and experience must be applied to determine what relationships make sense. Finally, the candidate models must be checked for adequacy. We examine the mean absolute percentage error (MAPE) as one measure of the model's sufficiency. The derivation of the MAPE was discussed in Section 2.4.1.

3.2.3 REGRESSION CONSIDERATIONS

In the use of regression for forecasting business base areas, several key concepts must be addressed:

(1) Forecast elements. Forecast elements are the particulars that need to be predicted, also called dependent variables. This comes from the concept that the movement of these elements is *dependent* on the movement of other forces, of other elements (variables) in the equation. For this study, the elements being forecast are: gross demands, supply support requests, and gross sales. Gross demands are the number of requests that are received as orders for goods. Gross demands were used, as opposed to net, because work is put on the system to process a demand from receipt, whether or not it ends up canceled etc. A supply support request is a solicitation of assistance/information for new items without National Stock Numbers (NSN) within DLA. Gross sales is the dollar value of goods issued by DLA prior to returns and adjustments.

(2) Influencing factors. It is important to identify those elemental factors that rationally have an effect on the forecast variables. Once influencing variables have been identified, the relationship between the forecast variables and the influencing factors should be examined for reasonableness. In looking at these influencing variables it is important to find those that are "prime movers" and do in fact cause changes, as opposed to those that are only associated with changes.

Everyone of these data elements were considered in the formulation of the forecast. Influencing factors were evaluated in multiple combinations and singularly against each of the elements being forecast, and included or discarded in favor of others based on analysis and instinctive interpretation.

3.3 DEMAND FORECAST

After evaluating the influencing areas (Section 2.3) by regression and statistical analysis, the following three drivers were arrived at for the demand forecast: active duty military end strength, Air Force flying hours, and Budget Authority - procurement. These three drivers showed themselves to be best influencing factors with the highest relationship to movement of the gross demands within DLA. It was a matter of investigation, trial and error, and analysis to find the prime movers behind the elements being predicted and include them in the formulation.

The appropriateness of military personnel end strengths for inclusion as an influencing variable in the demand forecast is apparent. It is the people within the services that are the consumers and users of the products DLA provides. In using the model to forecast, it is significant that the Department of Defense downsizing calls for a 14.8% decrease in the size of the force from 1993 to 1999. The resulting force is projected to be 1.453 million by 1999-- a 31.8% decrease from 1989.

The second independent variable chosen for inclusion in this formula was Air Force flying hours. Of the operations tempo indicators evaluated for each of the services -- Air Force flying hours, Army flying hours, Navy flying hours, Navy steaming hours, and Army tank training miles -- it was Air Force flying hours that had the most influence on gross demands in DLA. Past Air Force flying hours were taken from historical data available. The out year projections were then computed using a five year average of the increase/decrease of USAF personnel strength, flying hours, and outlays. The calculated hours used for this model are in Table 3-1. The result was a 4.85 percentage decrease per year in flying hours for the next six years. The point in the future when flying hours will stabilize needs to be pinpointed. The Air Force out-year projections are classified and therefore not a part of this study. This area is addressed in the Section 5. Flying hours have declined 25 percent faster than personnel, and 94 percent faster than outlays in the previous five period (1989 - 1993).

The third independent variable chosen was the Budget Authority (BA) for procurement dollars. This was an interesting result as the intuitive variable would have been the money allocated for operations and maintenance (O&M). The best explanation for BA having the greatest relationship to demand and the other forecasted indicators is that the DLA hardware center business is in sum a small percentage of the total amount budgeted for operations and maintenance. Movements in O&M away from areas of DLA concern, such as base capital improvements and quality of life issues, do not effect DLA business base. The dollars spent on base improvement would be primarily local procurement of real property enhancements and the like, not for purchasing DLA provided spare parts, etc. A better relationship was achieved with procurement. Money available for purchases is a more influential relationship in regards to spare parts and other elements of DLA business.

Table 3-1. Estimated USAF Flying Hours, 1994 - 1999

FY	Estimated Flying Hours
1994	2,420,848
1995	2,303,437
1996	2,191,720
1997	2,085,422
1998	1,984,279
1999	1,888,041

The mathematical formula for the Demand forecast is

$$Y = 7.47634X_1 + 10425.47X_2 + .032301X_3$$

where: Y = Number of Demands

X_1 = Military End Strengths

X_2 = BA Procurement

X_3 = USAF Flying Hours.

Using the above model, the forecast for gross demands is shown in Table 3-2.

Table 3-2. Six Year Forecast of Gross Demands DLA Hardware Centers

FY	Gross Demands
1994	12,597,215
1995	11,999,144
1996	11,779,347
1997	11,548,952
1998	11,488,923
1999	11,435,025

The values for the thirteen previous years were backcasted using the formula given previously. The Mean Absolute Percentage Error (MAPE) was then calculated for the backcasted years. The MAPE for gross demands over that period was 3.88%. This low percentage is outstanding. This means that on average the forecast was within 3.88% of the actual value. The R-squared value for this forecast was .84. This is a very high value and indicates that the equation captures most the movement of the forecasted element. The residual analysis is detailed in Appendix C.

3.4 SUPPLY SUPPORT REQUEST FORECAST

The three prime movers behind the SSR movement were Budget Authority for procurement, military personnel end strengths, and the gross demands from the previous forecast.

The mathematical formula for the Supply Support Request forecast is

$$Y = -142147 + .006349X_1 + .064161X_2 + 1009.61X_3$$

where: Y = Number of Supply Support Requests

X_1 = Forecasted Gross Demands

X_2 = Military End Strength

X_3 = Budget Authority - Procurement.

Using this formula, the forecast for SSRs is shown in Table 3-3. Of note is the slight raise in the number of SSRs in FY98. This is a reflection of increased BA-procurement spending in that year. Using the gross demands previously forecasted has the effect of adding additional weight to military personnel levels and procurement as they are a part of the this figure. This also has the effect of capturing service activity, as USAF flying hours are captured in the demand forecast.

Table 3-3. Six Year Forecast of Supply Support Requests
DLA Hardware Centers

FY	SSRs
1994	87,043
1995	82,103
1996	79,588
1997	74,061
1998	75,217
1999	73,335

Evaluating this forecast using the MAPE shows an average 9.44% error for the ten years backcasted (1984 - 1993). This percentage is lower than the +/- 15% error found in several previous estimates. The R-squared for this regression was .78. This value is good because it shows that the equation captures most (three-quarters) of the movement of SSRs. The residual analysis is detailed in Appendix C.

3.5 SALES FORECAST

For this forecast the number of independent variables used were two: BA-procurement and the gross demands from that forecast. The mathematical formula for the Sales Forecast is

$$Y = 1411.08 + .00102X_1 + 7.7073409X_2$$

where: Y = Gross Sales

X_1 = Forecasted Gross Demands

X_2 = Budget Authority - Procurement.

The six year forecast is shown in Table 3-4. The figure shown in this formula, 1411.08, indicates a sales base of $1.411 billion for the four hardware centers. The inclusion of gross demands from the previous forecast has the same effect as it did earlier. Namely, giving additional weight to BA-procurement, and at the same time capturing service activity, and personnel strength.

Table 3-4. Six year Forecast of Gross Sales
DLA Hardware Centers

FY	Gross Sales
1994	$3,017,129,000
1995	$2,986,541,000
1996	$2,969,781,000
1997	$2,930,011,000
1998	$2,939,450,000
1999	$2,925,464,000

At issue may be the small number of drivers used in this regression. With the present variables taking into account the driving forces behind DLA business, this should present no problem. The forecast reflects the underlying tenant that DLA business is derived from military personnel training with the funds available. This is instinctively apparent, and the model mirrors this. Notwithstanding, it has proven best to search out a small number of the most crucial factors and model them well and simply, rather than trying to incorporate every possible factor in a complex model.

Evaluating this forecast using the MAPE shows an average 6.12% error for the thirteen years backcasted (1981 - 1993). The R-squared for this model was .48. This is only an average outcome. This is indicative of the fact that gross sales is a complex area to forecast, with many movers behind it. The regression equation captures about half of the movement in gross sales. This is worthwhile, and a good figure for a real-world application. The residual analysis is detailed in Appendix C.

SECTION 4
CONCLUSIONS

The diminishing resources within the Department of Defense have a direct and expeditious impact on the business base of the Defense Logistics Agency. DoD funding is the leading indicator of future sales and related activity. The Budget Authority for procurement is *the* prime mover effecting the business base indicators studied during this project.

The sales of DLA Hardware Centers will decline and become relatively flat at the $3 billion per year level given current conditions and trends of declining manpower, operations activity, and funding. Gross demands will drop accordingly, and stabilize at approximately 11.5 million per year. Supply Support Requests will also deteriorate to a level of roughly 75,000 as fewer National Stock Numbers enter the inventory.

Finally, any forecast should not be used to the exclusion of known information. Information may become available concerning the future business of DLA that was not an element of this model. This information must be factored into the forecast and evaluated continuously.

SECTION 5
RECOMMENDATIONS

On the basis of analysis of the forecasting model developed for this project, the following recommendations are in order:

The 6-year forecast of gross demands, supply support requests, and gross sales should be used in the overall planning and evaluation process at DLA.

DLA should continue to gather data on service activity indicators, DoD budget items, and military personnel strengths. Evaluating this data relative to the models on a periodic basis should be done to examine developing relationships between DLA business and DoD activity.

DLA should consider the possibility of updating the forecast coefficients using military service out-year projections of the variables. The use of this data would have to be weighed against the event the forecast became classified.

DLA should consider expanding future efforts to forecasting specifically for the Defense Personnel Supply Center (DPSC) and the Defense Fuel Supply Center (DFSC).

APPENDIX A

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APPENDIX B

FORECAST VARIABLE DATA

APPENDIX B

LIST OF TABLES

Table B-1. Service Activity/OPTEMPO Indicators

FY	AIR FORCE FLYING HOURS	NAVY FLYING HOURS	NAVY STEAMING HOURS	ARMY FLYING HOURS	ARMY TANK MILES
1982	3,351,727	2,011,077	1,176,454	1,573,983	na
1983	3,402,755	2,096,714	1,234,688	1,588,758	na
1984	3,441,313	2,150,416	1,321,177	1,567,003	na
1985	3,476,816	2,097,840	1,246,986	1,551,460	na
1986	3,456,619	2,196,243	1,203,089	1,669,276	na
1987	3,462,588	2,302,492	1,228,104	1,711,894	844
1988	3,340,085	2,151,971	1,282,202	1,720,864	828
1989	3,411,884	2,227,807	1,249,217	1,672,999	815
1990	3,365,780	2,151,149	1,208,325	1,693,690	733
1991	3,665,578	2,066,557	1,344,760	1,439,796	1291
1992	2,767,204	1,912,679	1,049,426	1,460,341	736
1993	2,544,244		1,089,000	1,371,670	588

Table B-2. Department of Defense Budget Figures

FY	Outlays (Billions $)			Budget Authority (Billions $)		
	O & M	Prourement	RDT&E	O & M	Procurement	RDT&E
1980	73.8	57.1	23.1	75.0	58.8	22.8
1981	77.2	61.6	24.4	81.9	74.2	25.8
1982	84.1	67.5	26.3	87.8	93.8	29.5
1983	89.8	78.2	29.5	91.7	112.0	32.3
1984	91.9	84.9	31.8	96.4	116.1	36.7
1985	96.6	93.3	36.1	103.6	126.6	41.6
1986	99.4	98.7	41.9	98.7	117.2	43.4
1987	97.5	101.4	42.4	101.5	98.2	44.6
1988	104.9	94.1	42.5	100.7	94.3	44.1
1989	103.1	95.5	43.4	101.5	90.3	43.5
1990	101.1	91.0	42.2	100.4	89.6	40.6
1991	108.0	88.4	37.3	124.4	76.9	38.9
1992	97.0	78.6	36.3	98.8	63.8	38.4
1993	93.3	70.2	38.2	88.5	54.8	39.0
1994	89.1	62.2	38.2	89.5	45.4	36.9

Table B-3. Dependent Variable Data

FY	Supply Support Requests	Gross Demands	Gross Sales (Millions $)
1981		16,471,913	3,298.0
1982		17,030,831	3,788.5
1983		17,969,561	4,277.6
1984	250,628	18,537,678	4,242.8
1985	233,729	17,807,773	4,363.7
1986	205,058	16,590,858	3,855.3
1987	212,291	16,517,037	3,951.0
1988	222,991	15,549,692	3,592.0
1989	179,967	16,453,118	3,253.3
1990	146,066	16,242,333	3,234.9
1991	144,695	15,902,100	3,945.3
1992	152,466	15,180,716	3,615.9
1993	113,114	14,097,513	3,442.3

Table B-4. Personnel Strength and MRO Data

FY	MROs	Personnel
1981	11,130,256	2,082,560
1982	11,712,906	2,108,612
1983	12,029,964	2,123,349
1984	12,680,339	2,138,157
1985	13,136,546	2,151,032
1986	13,098,430	2,169,112
1987	13,194,006	2,174,217
1988	12,462,356	2,138,213
1989	13,127,891	2,130,229
1990	12,991,818	2,043,705
1991	12,942,376	1,985,555
1992	11,918,520	1,808,131
1993	10,804,692	1,705,103
1994		1,611,176

APPENDIX C

FORECAST ANALYSIS DATA

APPENDIX C
LIST OF TABLES

Table C-1. Gross Demands Analysis

FY	Gross Demands	Gross Demands Forecast	Error (ABS value)	Percent Error
1981	16,471,913	16,447,961	23,952	0.15
1982	17,030,831	16,850,878	179,953	1.06
1983	17,969,561	17,152,448	817,112	4.55
1984	18,537,678	17,307,148	1,230,530	6.64
1985	17,807,773	17,514,020	293,753	1.65
1986	16,590,858	17,550,540	959,682	5.78
1987	16,517,037	17,390,816	873,779	5.29
1988	15,549,692	17,077,022	1,527,330	9.82
1989	16,453,118	16,977,948	524,829	3.19
1990	16,242,333	16,322,278	79,944	0.49
1991	15,902,100	15,764,809	137,291	0.86
1992	15,180,716	14,272,734	907,981	5.98
1993	14,097,513	13,401,431	696,082	4.94

Mean Absolute Percentage Error: 3.93%.

Table C-2. SSR Analysis

FY	SSRs (Actual)	SSRs (Forecast)	Error (ABS value)	Percent Error
1984	250,628	229,950	20,677	8.25
1985	233,729	236,743	3,014	1.28
1986	205,058	220,687	15,629	7.62
1987	212,291	201,363	10,927	5.15
1988	222,991	188,974	34,016	15.26
1989	179,967	190,159	10,192	5.67
1990	146,066	182,562	36,496	24.99
1991	144,695	163,849	19,154	13.24
1992	152,466	134,660	17,805	11.68
1993	113,114	112,085	1,028	0.91

Mean Absolute Percentage Error: 9.44%

Table C-3. Gross Sales Analysis

FY	Gross Sales	Gross Sales Forecast	Error (ABS value)	Percent Error
1981	3298.00	3687.40	389.35	11.81
1982	3788.50	3857.40	68.93	1.82
1983	4277.60	4104.30	173.25	4.05
1984	4242.80	4235.60	7.22	0.17
1985	4363.70	41085.00	155.22	3.64
1986	3855.30	3825.80	29.55	0.77
1987	3951.00	3760.10	190.91	4.83
1988	3592.50	3544.80	47.75	1.33
1989	3253.30	3725.70	472.44	14.52
1990	3234.90	3679.20	444.31	13.73
1991	3945.30	3573.60	371.64	9.42
1992	3615.90	3386.20	229.66	6.35
1993	3442.30	3132.90	309.40	8.99

Mean Absolute Percentage Error: 6.12%

APPENDIX D
LIST OF SOURCES

LIST OF SOURCES

Defense Manpower Data Center, 1600 Wilson Blvd., Suite 400, Arlington, VA 22209

Active Duty Military Strength, Historical, POC: Ms. Zee Ferris, (703) 686-5823

Selected Reserve Personnel Strength, Historical and Projected, POC: LTC Gilbert, (703) 696-6790

Department of the Army, Deputy Chief of Staff for Operations (Training), DCSOPS-TR.

Tank Training Miles, POC: CPT Robert Aikem, DSN 224-1260

Army Flying Hours, POC: Mr. Fred Kolstrom, Army Flying Program Manager, DSN 227-9025

Department of the Navy, Comptrollers Office, Pentagon

Navy Steaming Hours, POC: LCDR Scott Robinson, DSN 224-7418

Logistics Management Institute, 6400 Goldsboro Road, Bethesda, Maryland 20817-5888

Navy Flying Hours, Air Force Flying Hours, POC: Mr. Tovey Bachman, (301) 320-7361

Office of the Assistant Secretary of Defense (Military Personnel Policy), 4000 Defense Pentagon, Washington, D.C., 20301-4000

Active Duty Military Strength, Current and Projected, POC: COL Moore, DSN 225-6312

NOTE: Sources of data elements/variables not listed above are given in text and/or bibliography of this report.

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13. ABSTRACT *(Maximum 200 words)*

The Defense Logistics Agency (DLA) is the primary worldwide supplier of consumable items and repair parts to the Department of Defense (DoD), and provides for other government agencies as requested. Decreases in the DoD budget, base closures, declining military personnel end-strengths, streamlining initiatives, and many other factors are combining to drastically effect DLA's business base. The Material Management directorate within DLA requires a model to forecast indicators of workload in order to assist in corporate strategic planning and resource allocation in the area of supply management. The model encompasses four hardware centers supplying construction, electronic, general, and industrial items. Annual sales from these centers exceed $3 billion. Indicators of workload included in the forecast are gross demands, supply support requests, and gross sales. This project discusses development of the model and evaluation of the forecasts. Included are the various methodologies considered, assessment of independent variables, and application of the forecasts within DLA.

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